RVAP: AN ASSESSMENT OF THE ICBM REENTRY SYSTEM INDUSTRIAL BASE *

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Abstract

The RV Applications Program (RVAP), was initiated in 1994-95 by the ICBM System Program Office, with Lockheed Martin Missile & Space (LMMS) as a participant, to evaluate the status of the US industrial base for sustainment of silo-based ICBM reentry systems (RS). The elements of the activities (skills, products, test facilities) required for the engineering, production and operational phases of an RS were compiled. An evaluation process was developed to screen these elements for those critical for sustainment of the industrial base. The LMMS evaluation selected half of the approximately 100 identified activities as critical. This paper describes the process of identifying the activity elements and lists them. It then describes the evaluation process and lists the results.

Nomenclature

ATE = Activity Tree Element
C/C = carbon/carbon
EMD = Engineering, Manufacturing & Development
EPI = Engineering Process Improvement
ICBM = Intercontinental Ballistic Missile
IPT = Integrated Product Team
NSWC = Naval Surface Warfare Center
OT&E = Operational Test & Evaluation
RB = reentry body (USN)
RS = reentry system
RV = reentry vehicle (USAF)
RVAP = Reentry Vehicle Applications Program
SEMP = Systems Engineering Management Plan

I. Background

The Minuteman III Missile system was initially deployed in 1969-1972 with the Mk12 reentry vehicle (RV). A partial retrofit with the Mk12A RV was carried out in 1979-82. Peacekeeper, the newest USAF ICBM, was deployed in the late 1980's and includes the Mk21 RV in its reentry system (RS). There are continuing Operational Test and Evaluation (OT&E) flights for both missiles, but manufacturing of reentry systems for the AF has ceased. This was preceded by discontinuance of any major Engineering, Manufacturing & Development (EMD) phase work. The EMD phase exercised many missiles and science engineering skills and test facilities which are unique, or very nearly so, to ICBM RS work. The manufacturing phase also used skills, facilities and (in particular) materials not available in other aerospace or defense systems.

In 1994, the USAF initiated the Reentry Vehicle Application Program (RVAP) to assess the status of the land silo-based reentry system ICBM industrial base. This paper describes the work done by LMMS, the methodology developed and the results of that assessment. These results were one input used by the USAF to define the subsequent activities in RVAP.

II Approach

2.0 Activity Trees

2.1 Derivation and Description of The Complete Activity Trees

The end item sought in this activity was the identification and compilation of those items which must be maintained in order to assure a viable industrial base for maintaining reentry systems capability. Our overall process for accomplishing this is shown in Figure 1.

One of the first tasks undertaken on this program was to formally identify and list the activity tree elements (ATE's) that comprise the ICBM reentry system industrial base. The term "Activity Tree Element" was derived from the definition of an "Activity Tree" contained in the document "Reentry Vehicle Industrial Base Assessment, Cookbook for Implementation" (1) as the:

> Definition of all activities necessary to carry out a Production/Deployment Program .. (and) .. an Operation & Support Program.

As depicted in Figure 1 a dedicated team of specialists is convened as an Integrated Product Team. These specialists synthesize an overall list of ATE's which are then operated on in a formalized process.

* This work was performed under USAF Contract No. F42610-95-D-0026 for Air Force Material Command, Hill AFB, UT

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We categorized the potential ATE's into four types of activity:

- Engineering skills
- Products (including manufacturing skills)/processes/materials
- Test facilities
- Documentation

In this paper, the identified ATE's are written with capital first letters and italicized; e.g. *Reentry System Engineer* is a skill, *Carbon/Carbon Nosetip Billet* is a material/product, *HIPIC Preform Densification* a process or production facility, *Reentry System Test Set* is a test facility and *National Archives* is captured in the Documentation category.

We considered the reentry system lifecycle in three phases. The Engineering and Manufacturing Development (EMD) phase is chronologically the first. It is the one most closely identified with high technology engineering and design effort. It also requires the use of special test facilities, including flight test, and access to past documentation of technology and design work. It also calls for detailed documentation of the work done in this phase.

The Production & Deployment phase makes most intensive use of component parts and materials and processes, while also requiring selective continuing use of engineering talent for review of processes and evaluation of the effects of specification and manufacturing procedure changes. It is important that these revisions be properly documented in the manufacturing data base. Test facilities also continue to be used in this phase.

In the Operational Test & Evaluation (OT&E) phase, continuing flight mechanics engineering services such as *Analyses of Reentry Flight Dynamics and Accuracy* are also provided for the OT&E flight tests which continue throughout the deployed lifecycle of the RS. Also included are the maintenance and revision of test equipment such as *Radar Range Simulators*, all the more so in recent years as service life is stretched well beyond original expectations. Various engineering skills usually associated with the development phase are occasionally required.

Our approach to developing the list of ATE's was initially to brainstorm with the RVAP Integrated Product Team at our company and collect their joint compilations. Table 1, "RS, RV/RB and Fuze Activity Tree Identification" displays some of the sources of this information by lifecycle phase and gives examples that readily came to mind.

The list of all Activity Tree Elements identified by this process is given in Tables 2 through 4 for the EMD, Production and OT&E phases, respectively. Note that the ATE's are grouped by the same technical disciplines (Systems, Aerothermostructural, Materials . . .) as the discipline makeup of our IPT (Figure 1).

2.2 Discussion of Activity Tree and ATE Characteristics

We have observed that the sources for identification of the ATE's appear to be better documented for the Production & Deployment and OT&E phases than for the Engineering & Manufacturing phase. There are drawing trees, materials and process specification trees, parts lists, manufacturing standing instructions and other highly standardized descriptions for the manufacturing process. Similar detailed planning exists for the OT&E phase.

In the case of the Production phase callout of the various components via drawing trees, we chose in most cases to designate the ATE's at the subsystem level only. For example, the fuze and other RV electrical subsystems are called out as *Hardened Electrical Power Supplies/Batteries*, *Digital S/S*, *Analog S/S*, etc. To attempt to enumerate every drawing tree and parts list element of the subsystems would not have served any valid purpose for this program. However, the importance of certain classes of components was recognized by ATE callouts such as *Hardened Electrical Parts*, *Fuze Components* and *Cables*.

Similarly for the materials ATE's, we cite *ESM Aft Cover Heatshield Material* and *Hardened Composite Antenna Window Material* at this "top" subsystem level, without reference to the many component materials and process specifications which are key to production of RV component parts from these materials.

Consider, however, another set of related materials ATE citations for the specs underlying production of the *Carbon/Carbon Nosetip Billet* cited as an example in Table 1: i.e. *HIPIC Preform Densification* and *3D Graphite Fiber Preform Weaving* (both process and facility

specs) and *Coal Tar Pitch* and *Graphite Yarn, 1000/3000 Filament* (materials component specs). This is a relatively comprehensive call-out of materials and process specifications, absent the top level drawing callout for the fabrication of the *Carbon/Carbon Nosetip* itself from the *C/C Nosetip Billet.* Another example from Table 1 is the *"Rayon Fiber for Tape Wrapped Carbon Phenolic Heatshield."* We have to some degree therefore anticipated the importance of calling out certain ATE's at subsystem and component levels for recognition in an "unbundled" way in the subsequent Critical Attribute Assessment process.

Compared to the Production and O&S phases, the Engineering phase has not been standardized to this degree, despite such provisions as Systems Engineering Management Plans (SEMP) and Configuration Management Military Standards. In recent years aerospace firms have implemented surveys and institutionalization of "best practices" in certain design technology areas, notably electronic parts and circuit engineering. At Lockheed Martin (Air Force Reentry Systems Programs) and previously at GE Reentry Systems, the "Engineering Process Improvement" (EPI) program was developed to achieve this aim, and this practice has been sustained and institutionalized in our documentation and software procedures. The Integrated Product Team (IPT) is one such EPI practice for coordination of the various technical disciplines over the various phases of a program. Concurrent Engineering is another generic contemporary approach to assuring coordination of the phases of a program. However, there is no standardized/documented/comprehensive approach to the design of reentry systems or their reentry vehicle and fuze subsystems.

The compilation of the ATE list proceeded to preparation of the "Evaluation Form" for each ATE by assigned IPT members. This process created a detailed analysis of the ATE's that had been identified thus far and also highlighted gaps and overlaps in the activity tree coverage that were substantially ironed out in the process.

3.0 Assessment Methodology

This section describes the process and format which we developed and used to assess the need for government sustainment action with regard to the set of USAF silo-based ICBM reentry system activity tree elements (ATE's).

3.1 Description of Methodology

Our Assessment methodology grew out of an approach developed at NSWC and Sandia and described in the document "Reentry Vehicle Industrial Base Assessment, Cookbook for Implementation" previously cited as (1). We used the activity tree definition approach, distinguishing among the three phases of the RS lifecycle.

3.1.1 Classification of ATE's by Category and Effect on Assessment Process

The "Cookbook" defined three "Capabilities": Vendors, Test Facilities, and Engineering. These were also subsequently referred to as "Categories". The four analogous Categories that we defined are:

- Engineering skills
- Products/processes/materials
- Test facilities
- Documentation

The Engineering Skills and Test Facilities categories used for this analysis are the same as those used in the "Cookbook" - i.e. the definition of the categories, not the actual list of ATE's developed under them.

However, rather than use the category of Vendors, we have identified for assessment the vendors' actual output - products and materials - and the processes and facilities for producing them. This is considered to be a more robust and fundamental approach. Robust because the vendor industrial base may change, even disappear - this is the purpose for the RVAP programs' initiation. Fundamental because analysis in terms of the specified reentry system materials and products (components, subsystems) identifies the requirements for the generic processes and manufacturing facilities. The powerful microeconomic mechanism of the substitution effect can then be introduced into the analysis via consideration of such assessment criteria as uniqueness and availability.

In addition to the three categories used in the NSWC/Sandia cookbook, we have also introduced a new and fourth one: Documentation. This category is obviously an

implicit function within the engineering skill category and it is both utilized by and generated in the production and test-oriented categories. However, we observed repeatedly in the beginning of this work that explicit references to the various records and directions for performing the work of the reentry system lifecycle phases repeatedly surfaced in our attempts to describe and assess the processes.

The production phase for example has drawing trees: the drawings themselves, the underlying manufacturing instructions and material and process specifications. These documents are distinctly different from the materials, products and manufacturing facilities themselves, although they might be considered as implicit within the "process" category concept.

Similarly, the operations of the OT&E phase are documented formally in Tech Orders, the Operations Plan and in the Operations History.

Consideration of the EMD phase, however, showed that far less formal documentation exists for this high engineering skill-intense portion of the reentry system lifecycle. In working sessions to develop the ATE's and to develop this assessment methodology, the term "corporate memory" repeatedly arose when documentation was sought for the formal methods of performing reentry system design, the underlying analytic methods and the data bases of materials properties. This situation is portrayed in Table 1. The need for a separate category for Documentation was therefore evidenced.

3.1.2 Description of Development of Assessment Criteria and Scoring Procedure

Our goal was to develop a simple, user-friendly assessment process using the NSWC/Sandia Cookbook as a guide. It was also an objective to quantify the process, employing uniform scoring criteria to reduce subjectivity. The Cookbook was formulated to be quantitative. However, after review by our Integrated Product Team leaders, we found that strict adherence to the Cookbook format would have required a very intensive training of our team personnel in assigning the large number of required weighting factors and adhering to the scoring procedures as called for in that process. Assuming that this training were 100% successful, we also feared that the team corporate memory of it would be volatile and present problems with regard to the uniformity of application, even within the time span of this program.

Another consideration was that the Cookbook process called for a large number of evaluation criteria for each ATE. Our initial attempts to apply the format for the EMD phase invited modifications and additions as different team members attempted to use it. This raised the question of normalization of scores; if we had more evaluation criteria for one phase than another or for one category - products versus skills - bias would be inherent to the process.

Therefore, in the interest of using our program resources with economy and promoting maximum possible coherence within the team approach, it was decided to adapt the Cookbook concept, keeping its principal assessment criteria and sensitivities but seeking improved user-friendliness and internal consistency.

The elements of the assessment process that we developed are shown in Figure 2: "Assessment Process Flow". First, the list of Activity Tree Elements from the RS, RV and fuze is compiled. The sources and Categories of these are indicated. Then three sets of assessment criteria are applied.

The first assessment criterion is Uniqueness and it is applied as an unscored go/no filter. The criteria for evaluation are shown in Figure 3. Uniqueness is ascribed at two levels: unique to DoD utilization or the more unique case of utilization only for reentry system applications. Our original instructions to the evaluators included the consideration of a special category of items becoming no longer available, e.g. as a consequence of having been unique/special purpose for RV use only. However, this distinction generally was not applied - the Availability/Affordability filter was used for this aspect of the assessment.

The Evaluation Team used an ATE Evaluation Form which had been prepared for this purpose, see Figures 4A and 4B, the two sides of the actual forms used. The ATE is indicated to be either unique or non-unique. Space is provided for the rationale.

The next assessment criterion is Criticality. This evaluation is done on two levels. First was the criticality of the ATE to the

mission, scored 1 to 10, followed by the Probability of Need, also 1 to 10, for a combined possible score of 20 in this evaluation criterion. The set of detailed "Criticality Assessment Scoring Criteria" is shown as Figure 5.

Criticality itself is evaluated in terms of its impact on the mission, with four bracketed ranges of importance, the scoring in those brackets to be allotted proportional to the reviewer's perception of the need, normalized to the other ATE evaluations. However, the scoring for the additional consideration of Probability of Need was to be proportional to the degree that the combined statements in an entry field was perceived to apply to the ATE. In this manner the time factor for need was explicitly addressed, accounting for the possibility that an ATE, no matter how critical its role in a USAF ICBM reentry system, might not be needed for a long time; or alternatively, even if its function were not that critical per se, replacement might be required in the near future, thereby raising the indicated (combined) Criticality assessment score.

The third and final evaluation criterion is Availability/Affordability. This was the most difficult criterion combination for which to set up a consistent scoring scheme. It was realized that most of the difficulty originated from the differing Category types, e.g. products versus skills. Our study of the Cookbook approach which was detailed for products only (in the version we had) helped point the way to a appropriate screen for each category.

Figure 6 shows the scheme for Products (and Materials, Processes and Production Facilities). There are three screens, each with a maximum possible score of 10.

Current/Projected Capability measures availability in terms of several parameters including the current status, the likelihood that it can be reconstituted, the availability of key personnel and capability at the suppliers, the likelihood of alternates that can be qualified and substituted for the original product and other factors such as environmental regulations. Note that the highest scores are accorded for the least availability.

The next screen is Affordability. The guidelines in Figure 3-6 treat the degree of "unaffordability" in terms of the ratio of the cost-to-reconstitute to the cost-to-sustain. Again, the most serious condition receives the highest score.

The third screen is Availability Lead Time. Immediate or just-in-time availability for the anticipated program lead time is accorded the lowest score. The condition in which the product can be reconstituted, but at much delay to the program requirement, is accorded the maximum score, 9-10. Note that the drastic condition of never again being available is separated out here and reserved for the first parameter of this screen, i.e. the Current/Projected Capability.

The possible scoring under this criterion's combined set of three criterion screens is a maximum of 30. This score would be entered on the ATE Evaluation Form (Figure 4A and 4B) along with any comments or reservations.

Similarly, Availability/Affordability evaluations were performed on the ATE's in the Categories of Skills and Test Facilities. The scoring schemes for these categories are omitted from this paper for the sake of a reasonable brevity.

This overall Activity Tree Assessment Process is shown in Figure 7. The three filters are seen as an initial Uniqueness unscored go/no-go gate, followed by two scored combination filters in parallel. In addition to the quantitative scoring within each of these two filters, a voting criterion was also applied to the combination of the two.

In this final filter voting process, an ATE candidate which has received half or more of the potential scores under the Criticality evaluation (10 or more) **and** Availability/ Affordability (15 or more) is rated as a candidate for sustainment or a "Critical Attribute". An ATE not satisfying this criterion, but which has received a score of 8 or more in any assessment criterion, is rated as requiring additional review, regardless of total score. ATE's not meeting either of these criteria are rated as not a candidate for sustainment.

4.0 Results

The Activity Tree Elements (ATE's) identified by the IPT= and presented in Section 2 were individually assessed using the methodology outlined above in Section 3. The mechanism for accomplishing this evaluation was for the cognizant member of the team to fill out an

Element Evaluation Form for each identified ATE containing a brief rationale and scoring for it. An example of a completed form is shown in Figure 8. These assessment sheets were the basis for ranking the ATE's as to whether they should be sustained, reviewed or not sustained (no action). The resulting rankings are delineated for all of the ATE's in Table 5 through 7. These charts respectively address the relevant ATE's for the three program phases: EMD, Production and O&S. The ATE's are grouped according to technology area: Systems, Aerothermostructural, etc., and are ranked S (Sustainment Candidate), R (Additional Review), and NA (No Action).

A number of the ATE's are carried through more than one program phase, with many existing in all three phases. For instance, Hypersonic Aerodynamics and Heatshield Performance and Design are primarily required in the EMD phase of a program, but are also skills that are needed in the Production and O&S phases in order to consult upon and evaluate any manufacturing variation or observed off-nominal flight test behavior. Other ATE's such as Flight Test Design and Evaluation and RV Antenna Design Analysis are required during all program phases to support on-going test programs. As a result, while Tables 5 through 7 indicate the identification of 33 sustainment candidates in the EMD phase, 31 in the Production phase, and 22 in O&S phase, there exist only 44 which are unique.

A listing of the selected Sustainment Candidates is presented in Table 8, in which they are grouped by category (skill, product/ process, test or documentation) and by program phase (EMD, Production or O&S). In this compilation some candidate grouping has been developed. For instance, HIPIC Process for C-C and 3-D Graphite Fiber Preform Weaving have been grouped as elements of C-C Composite Nosetip Billet. Also, specific test equipment (e.g., Low Frequency Instrument Console) has been grouped together as Fuze Test Equipment. The compilation contained in Table 8 represents our recommended list of RV capabilities that must be sustained in order to assure a credible base for maintaining the ICBM fleet.

5.0 Conclusions

1. On RVAP we have derived a set of approximately one hundred ATE's which comprise the skills, products/ processes/ materials, documentation and facilities necessary for conduct of the EMD, production and OT&E phases of an ICBM reentry system.

2. A process has been developed to screen the set of ATE's on the basis of evaluation criteria of Uniqueness, Criticality and Availability/Affordability. Quantitative scoring criteria were developed and the process was exercised by our IPT. The process ranks ATE's into three groups: sustainment candidates ("critical attributes"), further review required and no action required (not critical).

3. Forty-four, or about half of the ATE's were rated as sustainment candidates or critical attributes of the ICBM reentry system industrial base. Recommendations have been made for sustaining engineering work in these areas.

References

1. "Reentry Vehicle Industrial Base Assessment, Cookbook for Implementation", Vu-Graph format document from NSWC.

TABLE 1: RS, RV/RB AND FUZE ACTIVITY TREE ELEMENT IDENTIFICATION

Phases of RS, RV/RB, Fuze Lifetime	Primary Sources of Activity Tree Elements	Examples of Activity Tree Elements
Engineering & Manufacturing Development	• Program SEMPs • Configuration Management Military Standards • Contract–Required Documentation of EMD (or equivalent) Program Approach • Corporate Memory of Methodology, Sensitivities (no single uniform specification of this "most technically intense" phase)	• *Hypersonic Aerodynamics & Heat Transfer Analysis* • *RV Antenna Design/Analysis* • *Plasma Dynamics Analysis* • *RV & Fuze NH&S Analysis* • *Materials Development & Characterization*
Production & Deployment	• Drawing Trees for RS and RV/RBs • Materials and Process Specification Trees • Parts Lists (well–defined at time of production)	• *Rayon Fiber for TWCP H/S* • *Fuze Electronic Components* • *C–C Nosetip Material* • *Aluminum Alloy Substructure Material*
Operation & Support	• Operations Plan (including A&S) • Operations History (including A&S) • Tech Orders (adequate documentation probably exists in government & industry)	• *Flight Test Analysis* • *Fuze & Electronic System Test* • *Long–term Aging Affects on Materials and Structure* • *Support Test Equipment (e.g. MM III RSTS)*

TABLE 2: IDENTIFICATION OF ALL ACTIVITY TREE ELEMENTS - EMD PHASE

SYSTEMS
- REQUIREMENTS DEVELOPMENT/SRA PROCESS
- WEAPON SYSTEM INTEGRATION
- FUZE SYSTEM ENGINEERING
- CONFIGURATION MANAGEMENT
- INTERFACE CONTROL
- CONFIGURATION CONTROL SYSTEM - MK12/12A
- DATA MANAGEMENT
- RELIABILITY ENGINEERING/FAILURE ANALYSIS
- FAILURE ANALYSIS CODES
- SYSTEM SAFETY/NUCLEAR CERTIFICATION
- HUMAN FACTORS
- LIFE CYCLE COST
- NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES)

AEROTHERMOSTRUCTURAL
- HYPERSONIC AERODYNAMICS
- HYPERSONIC HYDROEROSION
- PLASMA DYNAMICS
- NOSETIP PERFORMANCE/DESIGN
- HEATSHIELD PERFORMANCE/DESIGN
- ASCENT AEROTHERMAL EFFECTS
- INTERNAL HEAT TRANSFER
- STRUCTURES DESIGN
- STRUCTURAL DYNAMICS
- MECHANICAL NH&S
- MASS PROPERTIES
- OBSERVABLES
- HYPERSONIC WIND TUNNEL TESTING
- HYPERSONIC EROSION TESTING
- HYPERSONIC ABLATION TESTING
- AEROTHERMAL FLIGHT INSTRUMENTATION
- ABOVE GROUND TESTING (AGT)
- UNDERGROUND TESTING (UGT)

MATERIALS
- MATERIAL PROCESS TECHNOLOGIES
- NH&S CRITICAL MATERIALS/PROCESSES
- HIGH PERFORMANCE SUBSTRUCTURE MATERIALS
- RV/RS THERMAL PROTECTION MATERIALS DEV.
- ADVANCED ELECTROMAGNETIC MATERIALS DEV.

ELECTRICAL
- ELECTRICAL SYSTEMS ENGINEERING
- HARDENED ELECTRICAL POWER SUPPLY/BATTERIES
- DIGITAL S/S

ELECTRICAL (CONT'D)
- ANALOG S/S
- SENSORS/ELECTROMECHANICAL DEVICES
- RF S/S
- RV ANTENNA DESIGN/ANALYSIS
- INSTRUMENTATION & COMMUNICATIONS
- TRANSPONDERS & TRANSMITTERS
- ENCODERS
- ELECTRONIC HARDENING
- PARTS ENGINEERING
- PACKAGING
- CABLE DESIGN
- SOFTWARE ENGINEERING
- HIGH IMPULSE TRANSDUCER (HIT)
- FUZE SIGNAL MONITOR

FLIGHT MECHANICS
- REENTRY FLIGHT DYNAMICS/ACCURACY
- LAUNCH VEHICLE INTERFACE/TARGETING METHODS
- SYSTEM EFFECTIVENESS EVALUATION
- FLIGHT TEST DESIGN AND EVALUATION
- TELEMETRY DATA PROCESSING
- FLIGHT DATA PRODUCTS CONTRACTORS
- MOTION INSTRUMENTATION VENDORS

REENTRY SYSTEM
- REENTRY SYSTEM ENGINEER
- SHROUD STRUCTURE
- SHROUD ROCKET MOTOR
- DEPLOYMENT MODULE STRUCTURE
- DEPLOYMENT MODULE ELECTRONICS
- SEPARATION SYSTEMS - RVs
- SEPARATION SYSTEMS - SHROUD V-BAND
- PENAIDS

TEST SUPPORT
- LOW FREQUENCY INSTRUMENTATION CONSOLE
- RADIO FREQUENCY INSTRUMENTATION CONSOLE
- TEST CONTROL STATION
- ENVIRONMENTAL FACILITIES
- RADAR RANGE SIMULATORS
- SNLA THUNDER PIPE AND SEPARATION SHOCK FAC.
- SNLA LIGHT-INITIATED HIGH EXPLOSIVE FACILITY
- AURORA LINEAR ACCELERATOR (LINAC)
- SNLA SPUR III FOR PROMPT GAMMA

TABLE 3: IDENTIFICATION OF ALL ACTIVITY TREE ELEMENTS - PRODUCTION PHASE

SYSTEMS

- FUZE SYSTEM ENGINEERING
- CONFIGURATION MANAGEMENT
- INTERFACE CONTROL
- CONFIGURATION CONTROL SYSTEM - MK12/12A
- DATA MANAGEMENT
- RELIABILITY ENGINEERING/FAILURE ANALYSIS
- FAILURE ANALYSIS CODES
- HUMAN FACTORS
- LOGISTICS
- NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES)

AEROTHERMOSTRUCTURAL

- HYPERSONIC AERODYNAMICS
- NOSETIP PERFORMANCE/DESIGN
- HEATSHIELD PERFORMANCE/DESIGN
- MASS PROPERTIES
- AEROTHERMAL FLIGHT INSTRUMENTATION

MATERIALS

- NH&S CRITICAL MATERIALS/PROCESSES
- MATERIAL PROCESS TECHNOLOGIES
- CORROSION PREVENTION AND CONTROL
- JOINING TECHNOLOGIES
- HIGH PERFORMANCE SUBSTRUCTURE MATERIALS
- ESM AFT COVER HEATSHIELD MATERIAL
- HIPIC PREFORM DENSIFICATION, 3D GRAPHITE
- 3D GRAPHITE FIBER PREFORM WEAVING
- CARBON/CARBON NOSETIP BILLET
- COAL TAR PITCH
- GRAPHITE YARN, 1000/3000 FILAMENT
- REPLACEMENT FIBER FOR TWCP
- HARDENED SILICA COMPOSITE ANTENNA WINDOW MTL
- INDUSTRIAL CAPACITY TO PRODUCE TWCP H/S
- MODIFIED CARBON/CARBON NOSETIP (MK21)
- CARBON/CARBON TUNGSTEN CARBIDE COMPOSITE
- CARBON/CARBON NOSE ASSEMBLY
- VITREOUS FUSED SILICA ANTENNA WINDOW MATERIAL (MK12A)

ELECTRICAL

- ELECTRICAL SYSTEMS ENGINEERING
- HARDENED ELECT. POWER SUPPLIES/BATTERIES
- DIGITAL S/S
- ANALOG S/S
- SENSORS/ELECTROMECHANICAL DEVICES
- RF S/S
- RV ANTENNA DESIGN/ANALYSIS
- INSTRUMENTATION & COMMUNICATIONS
- TRANSPONDERS & TRANSMITTERS
- ENCODERS
- ELECTRONIC HARDENING
- AGT (HALAT)
- HARDENED ELECTRONIC PARTS
- CABLES
- HIGH IMPULSE TRANSDUCER (HIT)
- FUZE SIGNAL MONITOR
- FUZE COMPONENTS

FLIGHT MECHANICS

- REENTRY FLIGHT DYNAMICS/ACCURACY
- LAUNCH VEHICLE INTERFACE/TARGETING METHODS
- SYSTEM EFFECTIVENESS EVALUATION
- FLIGHT TEST DESIGN AND EVALUATION
- TELEMETRY DATA PROCESSING
- FLIGHT DATA PRODUCTS CONTRACTORS
- MOTION INSTRUMENTATION VENDORS

REENTRY SYSTEM

- REENTRY SYSTEM ENGINEER
- SHROUD STRUCTURE
- SHROUD ROCKET MOTOR
- DEPLOYMENT MODULE STRUCTURE
- DEPLOYMENT MODULE ELECTRONICS
- SEPARATION SYSTEMS - RVs
- SEPARATION SYSTEMS - SHROUD V-BAND
- PENAIDS

TEST SUPPORT

- LOW FREQUENCY INSTRUMENTATION CONSOLE
- RADIO FREQUENCY INSTRUMENTATION CONSOLE
- TEST CONTROL STATION
- ENVIRONMENTAL FACILITIES
- RADAR RANGE SIMULATORS
- REENTRY SYSTEM TEST SET

TABLE 4: IDENTIFICATION OF ALL ACTIVITY TREE ELEMENTS - OT&E PHASE

SYSTEMS

- FUZE SYSTEM ENGINEERING
- CONFIGURATION MANAGEMENT
- INTERFACE CONTROL
- CONFIGURATION CONTROL SYSTEM - MK12/12A
- DATA MANAGEMENT
- RELIABILITY ENGINEERING/FAILURE ANALYSIS
- FAILURE ANALYSIS CODES
- NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES

AEROTHERMOSTRUCTURAL

- HYPERSONIC AERODYNAMICS
- NOSETIP PERFORMANCE/DESIGN
- HEATSHIELD PERFORMANCE/DESIGN
- MASS PROPERTIES
- AEROTHERMAL FLIGHT INSTRUMENTATION

MATERIALS

- AGING EFFECTS ON TPS MATERIALS
- CORROSION PREVENTION AND CONTROL
- MATERIALS PROCESS TECHNOLOGIES

ELECTRICAL

- ELECTRICAL SYSTEMS ENGINEERING
- SENSORS/ELECTROMECHANICAL DEVICES
- RF S/S
- RV ANTENNA DESIGN/ANALYSIS
- INSTRUMENTATION & COMMUNICATIONS
- TRANSPONDERS & TRANSMITTERS
- ENCODERS
- HIGH IMPULSE TRANSDUCER (HIT)
- FUZE SIGNAL MONITOR
- HARDENED ELECTRICAL POWER SUPPLIES/ BATTERIES

FLIGHT MECHANICS

- REENTRY FLIGHT DYNAMICS/ACCURACY
- LAUNCH VEHICLE INTERFACE/TARGETING METHODS
- SYSTEM EFFECTIVENESS EVALUATION
- FLIGHT TEST DESIGN AND EVALUATION
- TELEMETRY DATA PROCESSING
- FLIGHT DATA PRODUCTS CONTRACTORS
- MOTION INSTRUMENTATION VENDORS

REENTRY SYSTEM

- REENTRY SYSTEM ENGINEER
- SHROUD STRUCTURE
- SHROUD ROCKET MOTOR
- DEPLOYMENT MODULE STRUCTURE
- DEPLOYMENT MODULE ELECTRONICS
- SEPARATION SYSTEMS - RVs
- SEPARATION SYSTEMS - SHROUD V-BAND
- PENAIDS

TEST SUPPORT

- LOW FREQUENCY INSTRUMENTATION CONSOLE
- RADIO FREQUENCY INSTRUMENTATION CONSOLE
- TEST CONTROL STATION
- ENVIRONMENTAL FACILITIES
- RADAR RANGE SIMULATORS
- REENTRY TEST SET
- RS COMPONENTS AGING AND SURVEILLANCE CONSOLES

TABLE 5: CLASSIFICATION OF ACTIVITY TREE ELEMENTS - EMD PHASE

	S	R	NA
SYSTEMS			
• REQUIREMENTS DEVELOPMENT/SRA PROCESS			X
• WEAPON SYSTEM INTEGRATION	X		
• FUZE SYSTEM ENGINEERING	X		
• CONFIGURATION MANAGEMENT			X
• INTERFACE CONTROL			X
• CONFIGURATION CONTROL SYSTEM - MK12/12A			X
• DATA MANAGEMENT			X
• RELIABILITY ENGINEERING/FAILURE ANALYSIS		X	
• FAILURE ANALYSIS CODES			X
• SYSTEM SAFETY/NUCLEAR CERTIFICATION			X
• HUMAN FACTORS			X
• LIFE CYCLE COST			X
• NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES)	X		
AEROTHERMOSTRUCTURAL			
• HYPERSONIC AERODYNAMICS	X		
• HYPERSONIC HYDROEROSION	X		
• PLASMA DYNAMICS	X		
• NOSETIP PERFORMANCE/DESIGN	X		
• HEATSHIELD PERFORMANCE/DESIGN	X		
• ASCENT AEROTHERMAL EFFECTS			X
• INTERNAL HEAT TRANSFER			X
• STRUCTURES DESIGN		X	
• STRUCTURAL DYNAMICS			X
• MECHANICAL NH&S	X		
• MASS PROPERTIES			X
• OBSERVABLES	X		
• HYPERSONIC WIND TUNNEL TESTING	X		
• HYPERSONIC EROSION TESTING	X		
• HYPERSONIC ABLATION TESTING	X		
• AEROTHERMAL FLIGHT INSTRUMENTATION		X	
• ABOVE GROUND TESTING (AGT)	X		
• UNDERGROUND TESTING (UGT)		X	
MATERIALS			
• MATERIAL PROCESS TECHNOLOGIES	X		
• NH&S CRITICAL MATERIALS/PROCESSES	X		
• HIGH PERFORMANCE SUBSTRUCTURE MATERIALS			X
• RV/RS THERMAL PROTECTION MATERIALS DEV.	X		
• ADVANCED ELECTROMAGNETIC MATERIALS DEV.	X		
ELECTRICAL			
• ELECTRICAL SYSTEMS ENGINEERING		X	
• HARDENED ELECTRICAL POWER SUPPLY/BATTERIES	X		
• DIGITAL S/S		X	

	S	R	NA
ELECTRICAL (CONT'D)			
• ANALOG S/S		X	
• SENSORS/ELECTROMECHANICAL DEVICES		X	
• RF S/S		X	
• RV ANTENNA DESIGN/ANALYSIS	X		
• INSTRUMENTATION & COMMUNICATIONS		X	
• TRANSPONDERS & TRANSMITTERS	X		
• ENCODERS		X	
• ELECTRONIC HARDENING	X		
• PARTS ENGINEERING		X	
• PACKAGING			X
• CABLE DESIGN			X
• SOFTWARE ENGINEERING			X
• HIGH IMPULSE TRANSDUCER (HIT)		X	
• FUZE SIGNAL MONITOR		X	
FLIGHT MECHANICS			
• REENTRY FLIGHT DYNAMICS/ACCURACY	X		
• LAUNCH VEHICLE INTERFACE/TARGETING METHODS		X	
• SYSTEM EFFECTIVENESS EVALUATION	X		
• FLIGHT TEST DESIGN AND EVALUATION	X		
• TELEMETRY DATA PROCESSING		X	
• FLIGHT DATA PRODUCTS CONTRACTORS	X		
• MOTION INSTRUMENTATION VENDORS		X	
REENTRY SYSTEM			
• REENTRY SYSTEM ENGINEER	X		
• SHROUD STRUCTURE			X
• SHROUD ROCKET MOTOR			X
• DEPLOYMENT MODULE STRUCTURE			X
• DEPLOYMENT MODULE ELECTRONICS	X		
• SEPARATION SYSTEMS - RVs		X	
• SEPARATION SYSTEMS - SHROUD V-BAND		X	
• PENAIDS		X	
TEST SUPPORT			
• LOW FREQUENCY INSTRUMENTATION CONSOLE	X		
• RADIO FREQUENCY INSTRUMENTATION CONSOLE	X		
• TEST CONTROL STATION	X		
• ENVIRONMENTAL FACILITIES		X	
• RADAR RANGE SIMULATORS	X		
• SNLA THUNDER PIPE AND SEPARATION SHOCK FAC.		X	
• SNLA LIGHT-INITIATED HIGH EXPLOSIVE FACILITY		X	
• AURORA LINEAR ACCELERATOR (LINAC)	X		
• SNLA SPUR III FOR PROMPT GAMMA		X	

S = SUSTAINMENT CANDIDATE **R = ADDITIONAL REVIEW** **NA = NO ACTION** **5/16/95**

TABLE 6: CLASSIFICATION OF ACTIVITY TREE ELEMENTS - PRODUCTION PHASE

	S	R	NA
SYSTEMS			
• FUZE SYSTEM ENGINEERING	X		
• CONFIGURATION MANAGEMENT			X
• INTERFACE CONTROL			X
• CONFIGURATION CONTROL SYSTEM - MK12/12A			X
• DATA MANAGEMENT			X
• RELIABILITY ENGINEERING/FAILURE ANALYSIS		X	
• FAILURE ANALYSIS CODES			X
• HUMAN FACTORS			X
• LOGISTICS			X
• NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES)	X		
AEROTHERMOSTRUCTURAL			
• HYPERSONIC AERODYNAMICS	X		
• NOSETIP PERFORMANCE/DESIGN	X		
• HEATSHIELD PERFORMANCE/DESIGN	X		
• MASS PROPERTIES			X
• AEROTHERMAL FLIGHT INSTRUMENTATION		X	
MATERIALS			
• NH&S CRITICAL MATERIALS/PROCESSES	X		
• MATERIAL PROCESS TECHNOLOGIES	X		
• CORROSION PREVENTION AND CONTROL			X
• JOINING TECHNOLOGIES			X
• HIGH PERFORMANCE SUBSTRUCTURE MATERIALS			X
• ESM AFT COVER HEATSHIELD MATERIAL	X		
• HIPIC PREFORM DENSIFICATION, 3D GRAPHITE	X		
• 3D GRAPHITE FIBER PREFORM WEAVING	X		
• CARBON/CARBON NOSETIP BILLET	X		
• COAL TAR PITCH		X	
• GRAPHITE YARN, 1000/3000 FILAMENT		X	
• REPLACEMENT FIBER FOR TWCP	X		
• HARDENED SILICA COMPOSITE ANTENNA WINDOW MTL	X		
• INDUSTRIAL CAPACITY TO PRODUCE TWCP H/S	X		
• MODIFIED CARBON/CARBON NOSETIP (MK21)		X	
• CARBON/CARBON TUNGSTEN CARBIDE COMPOSITE		X	
• CARBON/CARBON NOSE ASSEMBLY		X	
• VITREOUS FUSED SILICA ANTENNA WINDOW MATERIAL (MK12A)			X

	S	R	NA
ELECTRICAL			
• ELECTRICAL SYSTEMS ENGINEERING		X	
• HARDENED ELECT. POWER SUPPLIES/BATTERIES	X		
• DIGITAL S/S		X	
• ANALOG S/S		X	
• SENSORS/ELECTROMECHANICAL DEVICES		X	
• RF S/S		X	
• RV ANTENNA DESIGN/ANALYSIS	X		
• INSTRUMENTATION & COMMUNICATIONS		X	
• TRANSPONDERS & TRANSMITTERS	X		
• ENCODERS		X	
• ELECTRONIC HARDENING	X		
• AGT (HALAT)	X		
• HARDENED ELECTRONIC PARTS	X		
• CABLES			X
• HIGH IMPULSE TRANSDUCER (HIT)		X	
• FUZE SIGNAL MONITOR		X	
• FUZE COMPONENTS		X	
FLIGHT MECHANICS			
• REENTRY FLIGHT DYNAMICS/ACCURACY	X		
• LAUNCH VEHICLE INTERFACE/TARGETING METHODS		X	
• SYSTEM EFFECTIVENESS EVALUATION	X		
• FLIGHT TEST DESIGN AND EVALUATION	X		
• TELEMETRY DATA PROCESSING		X	
• FLIGHT DATA PRODUCTS CONTRACTORS	X		
• MOTION INSTRUMENTATION VENDORS		X	
REENTRY SYSTEM			
• REENTRY SYSTEM ENGINEER	X		
• SHROUD STRUCTURE			X
• SHROUD ROCKET MOTOR			X
• DEPLOYMENT MODULE STRUCTURE			X
• DEPLOYMENT MODULE ELECTRONICS	X		
• SEPARATION SYSTEMS - RVs		X	
• SEPARATION SYSTEMS - SHROUD V-BAND		X	
• PENAIDS		X	
TEST SUPPORT			
• LOW FREQUENCY INSTRUMENTATION CONSOLE	X		
• RADIO FREQUENCY INSTRUMENTATION CONSOLE	X		
• TEST CONTROL STATION	X		
• ENVIRONMENTAL FACILITIES		X	
• RADAR RANGE SIMULATORS	X		
• REENTRY SYSTEM TEST SET	X		

S = SUSTAINMENT CANDIDATE **R = ADDITIONAL REVIEW** **NA = NO ACTION** **5/16/95**

TABLE 7: CLASSIFICATION OF ACTIVITY TREE ELEMENTS - O&S PHASE

	S	R	NA
SYSTEMS			
• FUZE SYSTEM ENGINEERING	X		
• CONFIGURATION MANAGEMENT			X
• INTERFACE CONTROL			X
• CONFIGURATION CONTROL SYSTEM - MK12/12A			X
• DATA MANAGEMENT			X
• RELIABILITY ENGINEERING/FAILURE ANALYSIS		X	
• FAILURE ANALYSIS CODES			X
• NATIONAL ARCHIVES (ALL PHASES, ALL DISCIPLINES)	X		
AEROTHERMOSTRUCTURAL			
• HYPERSONIC AERODYNAMICS	X		
• NOSETIP PERFORMANCE/DESIGN	X		
• HEATSHIELD PERFORMANCE/DESIGN	X		
• MASS PROPERTIES			X
• AEROTHERMAL FLIGHT INSTRUMENTATION		X	
MATERIALS			
• AGING EFFECTS ON TPS MATERIALS	X		
• CORROSION PREVENTION AND CONTROL			X
• MATERIALS PROCESS TECHNOLOGIES	X		
ELECTRICAL			
• ELECTRICAL SYSTEMS ENGINEERING		X	
• SENSORS/ELECTROMECHANICAL DEVICES		X	
• RF S/S		X	
• RV ANTENNA DESIGN/ANALYSIS	X		
• INSTRUMENTATION & COMMUNICATIONS		X	
• TRANSPONDERS & TRANSMITTERS	X		
• ENCODERS		X	
• HIGH IMPULSE TRANSDUCER (HIT)		X	
• FUZE SIGNAL MONITOR		X	
• HARDENED ELECTRICAL POWER SUPPLIES/ BATTERIES	X		

	S	R	NA
FLIGHT MECHANICS			
• REENTRY FLIGHT DYNAMICS/ACCURACY	X		
• LAUNCH VEHICLE INTERFACE/TARGETING METHODS		X	
• SYSTEM EFFECTIVENESS EVALUATION	X		
• FLIGHT TEST DESIGN AND EVALUATION	X		
• TELEMETRY DATA PROCESSING		X	
• FLIGHT DATA PRODUCTS CONTRACTORS	X		
• MOTION INSTRUMENTATION VENDORS		X	
REENTRY SYSTEM			
• REENTRY SYSTEM ENGINEER	X		
• SHROUD STRUCTURE			X
• SHROUD ROCKET MOTOR			X
• DEPLOYMENT MODULE STRUCTURE			X
• DEPLOYMENT MODULE ELECTRONICS	X		
• SEPARATION SYSTEMS - RVs		X	
• SEPARATION SYSTEMS - SHROUD V-BAND		X	
• PENAIDS		X	
TEST SUPPORT			
• LOW FREQUENCY INSTRUMENTATION CONSOLE	X		
• RADIO FREQUENCY INSTRUMENTATION CONSOLE	X		
• TEST CONTROL STATION	X		
• ENVIRONMENTAL FACILITIES		X	
• RADAR RANGE SIMULATORS	X		
• REENTRY TEST SET	X		
• RS COMPONENTS AGING AND SURVEILLANCE CONSOLES	X		

S = SUSTAINMENT CANDIDATE **R = ADDITIONAL REVIEW** **NA = NO ACTION** **5/16/95**

TABLE 8: SUSTAINMENT CANDIDATE SUMMARY BY CLASS AND REENTRY SYSTEM LIFE PHASE

SKILLS	PRODUCT/PROCESS
DEVELOPMENT PHASE • WEAPON SYSTEM INTEGRATION • REENTRY SYSTEMS ENGINEERING (1) • FUZE SYSTEMS ENGINEERING (1) • RV ANTENNA DESIGN / ANALYSIS (1) • HYPERSONIC AERODYNAMICS (1) • HYPERSONIC HYDROEROSION • PLASMA DYNAMICS • OBSERVABLES • NOSETIP PERFORMANCE / DESIGN (1) • HEATSHIELD PERFORMANCE (1) • MECHANICAL NH&S • ELECTRONIC HARDENING • DEPLOYMENT MODULE ELECTRONICS • RV/RS MATERIALS TPS DEVELOPMENT • ADVANCED ELECTROMAGNETIC MATERIALS DEV. • MATERIAL PROCESS TECHNOLOGIES (INCL. NH&S, ENVIRONMENTAL ISSUES, BONDING, SPECIALIZED SUBSTRUCTURE MATERIALS) (1) • REENTRY FLIGHT DYNAMICS / ACCURACY (1) • REENTRY SYSTEM EFFECTIVENESS EVALUATION (1) • FLIGHT TEST DESIGN & EVALUATION (1)	**DEVELOPMENT PHASE** • TRANSPONDERS & TRANSMITTERS (1) • HARDENED ELECTRICAL POWER SUPPLY / BATTERIES (1)
NOTE (1): ALL PHASES	**PRODUCTION PHASE** • ESM AFT COVER MATERIAL • C-C COMPOSITE NOSETIP BILLET - HIPIC PROCESS FOR C-C - 3-D GRAPHITE FIBER PREFORM • REPLACEMENT FIBER FOR TAPE-WRAPPED CARBON PHENOLIC HEATSHIELD (TWCP) • INDUSTRIAL CAPACITY TO PRODUCE TWCP HEATSHIELD • HARDENED SILICA COMPOSITE ANTENNA WINDOW (e.g. AD3DQ) • HARDENED ELECTRONIC PARTS • NH&S CRITICAL MATERIALS / PROCESSES

TABLE 8 (Cont'd): SUSTAINMENT CANDIDATE SUMMARY BY CLASS AND REENTRY SYSTEM LIFE PHASE

TEST CAPABILITY/FACILITY

DEVELOPMENT PHASE

- HYPERSONIC WIND TUNNEL
- HYPERSONIC ABLATION TESTING
- HYPERSONIC EROSION TESTING
- ABOVE GROUND TESTING, e.g.:
  - AURORA LINEAR ACCELERATOR
  - ABERDEEN PULSE RADIATION FACILITY
- FLIGHT DATA PRODUCTS CONTRACTORS, e.g.:
  - XONTECH
  - AEROMET
- FUZE TEST EQUIPMENT, e.g.:
  - LOW FREQUENCY INSTRUMENT CONSOLE
  - RF INSTRUMENT CONSOLE
  - TEST CONTROL STATION
- RADAR RANGE SIMULATOR

PRODUCTION PHASE

- ABOVE GROUND TESTING (HALAT)
- FLIGHT DATA PRODUCTS CONTRACTORS
- FUZE TEST EQUIPMENT
- RS TEST SET

O&S PHASE

- FLIGHT DATA PRODUCTS CONTRACTORS
- FUZE TEST EQUIPMENT
- RS TEST SET
- RS COMPONENT AGING AND SURVEILLANCE CONSOLES
- AGING AND SURVEILLANCE OF TPS MATERIALS (RAYON-BASED CARBON PHENOLIC HEAT-SHIELD IN PARTICULAR)

DOCUMENTATION

DEVELOPMENT PHASE

- ARCHIVING OF EMD PHASE DESIGN METHODOLOGY, TEST AND ANALYSES, AND ALTERNATIVES LEADING TO SELECTED DESIGNS (ACROSS DISCIPLINES)

PRODUCTION PHASE

- ARCHIVE RS/RV DRAWINGS, SPECIFICATIONS AND MANUFACTURING PROCESS INSTRUCTIONS TEST DATA AND DATABASE OF PROBLEMS SOLVED / LESSONS LEARNED

O&S PHASE

- ARCHIVING OF FLIGHT TEST DATA AND ANALYSES, AND FIELD TEST PROBLEMS AND RESOLUTIONS

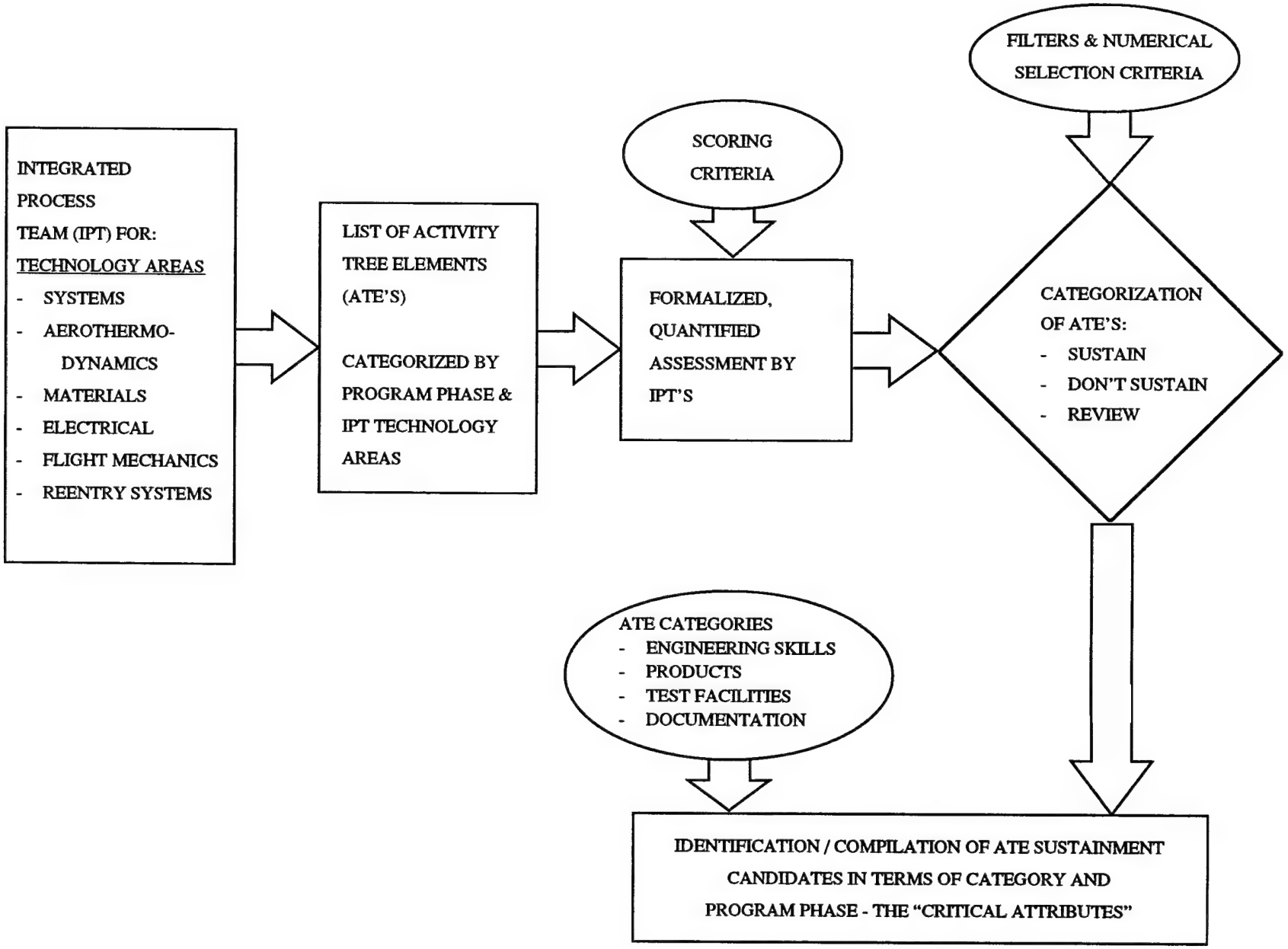

FIGURE 1: PROCESS FOR IDENTIFYING SUSTAINMENT CANDIDATES

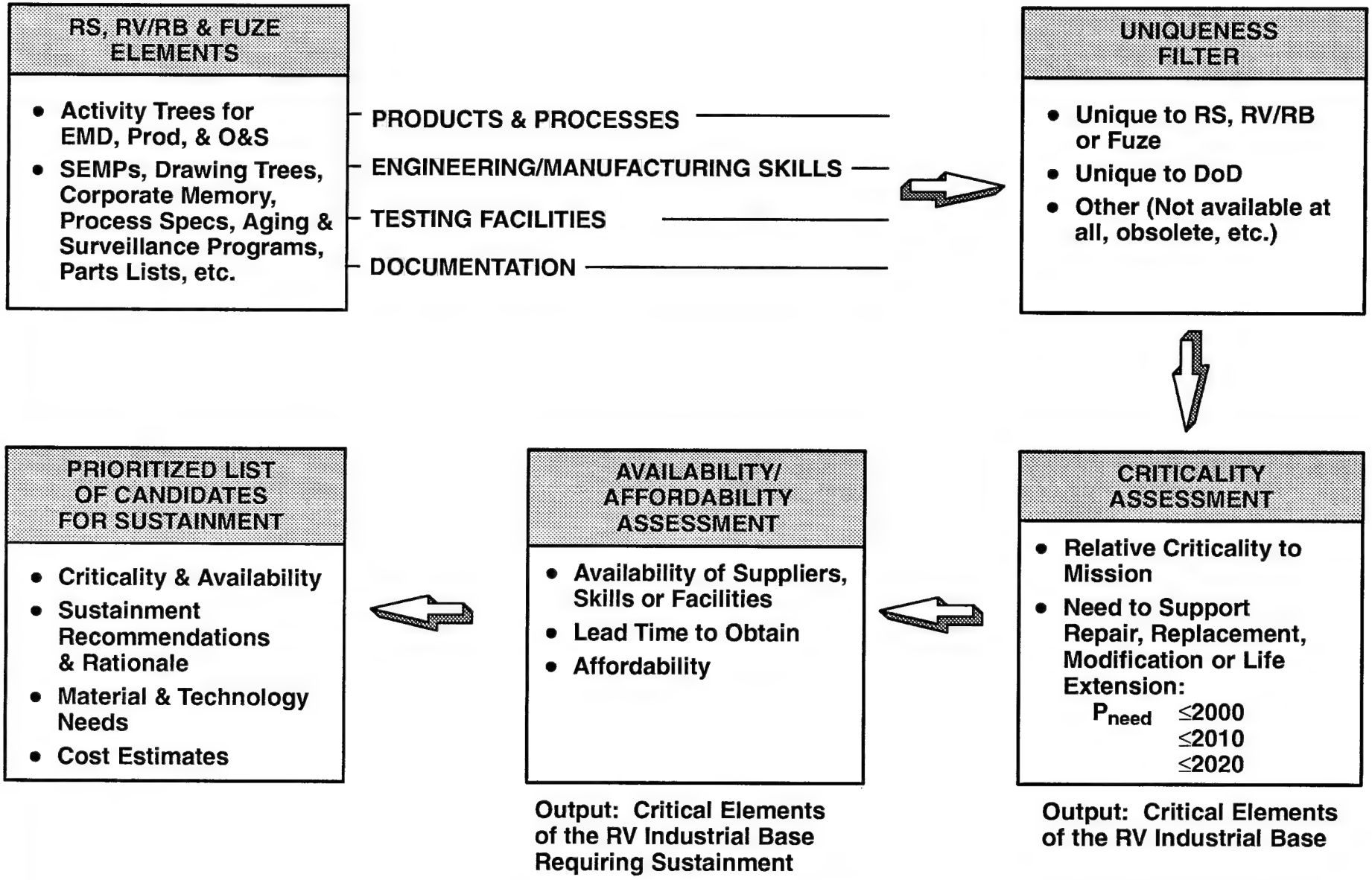

FIGURE 2: ASSESSMENT PROCESS FLOW

UNIQUENESS FILTER

- Unique to RS, RV/RB or Fuze
- Unique to DoD
- Other (Not available, obsolete, etc.)

Not Unique ⇨ **Non–Unique elements will be listed in the Final Report, along with a rationale and source(s) for the element**

⇩ ***Unique***

Unique elements will be further evaluated for criticality and availability

- **Elements that are utilized only by DoD**
- **Elements that are utilized only for reentry system and/or reentry vehicle/body applications**
- **Non–Unique (Non–DoD, Non–RV) elements that are no longer available or are obsolete**

FIGURE 3: UNIQUENESS FILTER

FIGURE 4A: RVAP ELEMENT EVALUATION FORM

MARTIN MARIETTA

Prepared By:

MARTIN MARIETTA ASTRO SPACE

ACTIVITY TREE ELEMENT IDENTIFICATION

☐ SKILL/TOOL	**Element Description:**
☐ PRODUCT/ PROCESS	
☐ TESTING REQUIREMENT	

Check all that apply

SYSTEM: ☐ MK–12A ☐ MK–21 ☐ MM III R/S ☐ MK–12 ☐ MK–5

Check all that apply

PHASE: ☐ EMD ☐ PROD ☐ O & S

UNIQUENESS FILTER

☐ NOT UNIQUE	**Rationale:**
☐ UNIQUE	

******* If "Not Unique", Do Not Proceed *******

CRITICALITY ASSESSMENT

Criteria	Score (1–10)	Rationale
CRITICALITY TO MISSION:		
PROBABILITY OF NEED:		
CRITICALITY TOTAL SCORE:		

AVAILABILITY & AFFORDABILITY ASSESSMENT

Criteria	Score (1–10)	Rationale
AVAILABILITY:		
LEAD TIME:		
AFFORDABILITY:		
AVAILABILITY TOTAL SCORE:		

SCORING RESULTS

Total Criticality ≥10 AND Total Availability ≥ 15	Any Individual Criterion Score ≥ 8	
☐ SUSTAINMENT CANDIDATE	☐ ADDITIONAL REVIEW NEEDED	☐ NO ACTION

FIGURE 4B: RVAP ELEMENT EVALUATION FORM

SUPPLIER & FACILITY INFORMATION

Supplier/Test Facility(s) last used: Current Status:

Alternate Supplier(s)/Facility(s): Current Status:

ADDITIONAL INFORMATION (if required)

Additional rationale, as needed, including: Supplier quality, Security concerns (personnel/facility clearances, computational capabilities), Others as determined by the teams.

SUSTAINMENT RECOMMENDATION

CRITICALITY TO MISSION

Assessment of the Activity Tree element's criticality to the Mission of the weapon system. Dependant upon operational requirements (e.g., current vs projected capability, life extension, targeting, range, accuracy, NH&S, Single RV, threats, etc.)

	SCORE
• *Small or no impact to mission.*	**1–2**
• *Moderate impact to mission.*	**3–5**
• *Significant impact to mission.*	**6–8**
• *Critical impact to mission. Immediate action must be taken.*	**9–10**

PROBABILITY OF NEED

Probability that this product/process, engineering/manufacturing skill, or test capability will be required to support the repair, replacement, modification or life extension of the RS, RV, RB or Fuze:

	SCORE
• *In the near–term (<2000) is very low.* • *In the intermediate term (2000 – 2010) is low.* • *In the far term (2010 – 2020) is low–moderate.*	**1–2**
• *In the near–term (<2000) is low.* • *In the intermediate term (2000 – 2010) is low–moderate.* • *In the far term (2010 – 2020) is moderate–high.*	**3–5**
• *In the near–term (<2000) is moderate* • *In the intermediate term (2000 – 2010) is moderate–high.* • *In the far term (2010 – 2020) is high.*	**6–8**
• *In the near–term (<2000) is moderate–high* • *In the intermediate term (2000 – 2010) is high* • *In the far term (2010 – 2020) is very high.*	**9–10**

FIGURE 5: CRITICALITY ASSESSMENT SCORING CRITERIA

CURRENT/PROJECTED AVAILABILITY

	SCORE
• *The specified product is available and/or is projected to be available when needed.* • *The specified product is available from many qualified sources.* • *Key personnel have been maintained and will be available when needed.* • *Key processes have been maintained and will be available when needed.*	**1–2**
• *The specified product is available either from original source(s) or qualified alternate source(s).* • *The product is not currently available, however the capability to produce can be reconstituted with some investment & lead time.* • *The product is available now, but will likely not be in the extended future (2010–2020).* • *Key processes are currently available, but may not be available when needed, due to continued inactivity or other factors.* • *Key personnel are currently available, however they may not be available when needed.*	**3–5**
• *The product is available now, but will likely not be in the near future (2000).* • *Key personnel are available, however they are assigned to other areas/programs, and will likely not be available when needed.* • *The product is no longer available, however an alternate exists that must be qualified.*	**6–8**
• *Key personnel and processes have been lost, or are rapidly eroding.* • *The product is no longer made and the supplier(s) have not/do not plan to retain the capability.* • *The product can no longer be made due to significant environmental restrictions, or other, factors.*	**9–10**

FIGURE 6: AVAILABILITY ASSESSMENT SCORING CRITERIA – PRODUCTS

AFFORDABILITY

	SCORE
• *The specified product is/will be available at reasonable cost.*	**1–3**
• *The specified product can be reconstituted, or a new source created, or a fit & function substitute evolved with modest investment. (Cost ≅ Cost–to–Sustain).*	**4–7**
• *The specified product cannot be reconstituted, or a new source created, or a substitute evolved without significant investment. (Cost >> Cost–to–Sustain)*	**8–10**

AVAILABILITY LEAD TIME

	SCORE
• *The specified product is available now (1995) or within the anticipated program lead time.*	**1–2**
• *The specified product can, with a high degree of certainty, be expected to be reconstitutable with modest schedule impact.*	**3–5**
• *The specified product can be expected to be reconstitutable with significant schedule impact, and will be a Critical Path Item on the program.*	**6–8**
• *The specified product can be expected to be reconstitutable, but the program will be lengthened significantly.*	**9–10**

FIGURE 6: AVAILABILITY ASSESSMENT SCORING CRITERIA – PRODUCTS (CONT.)

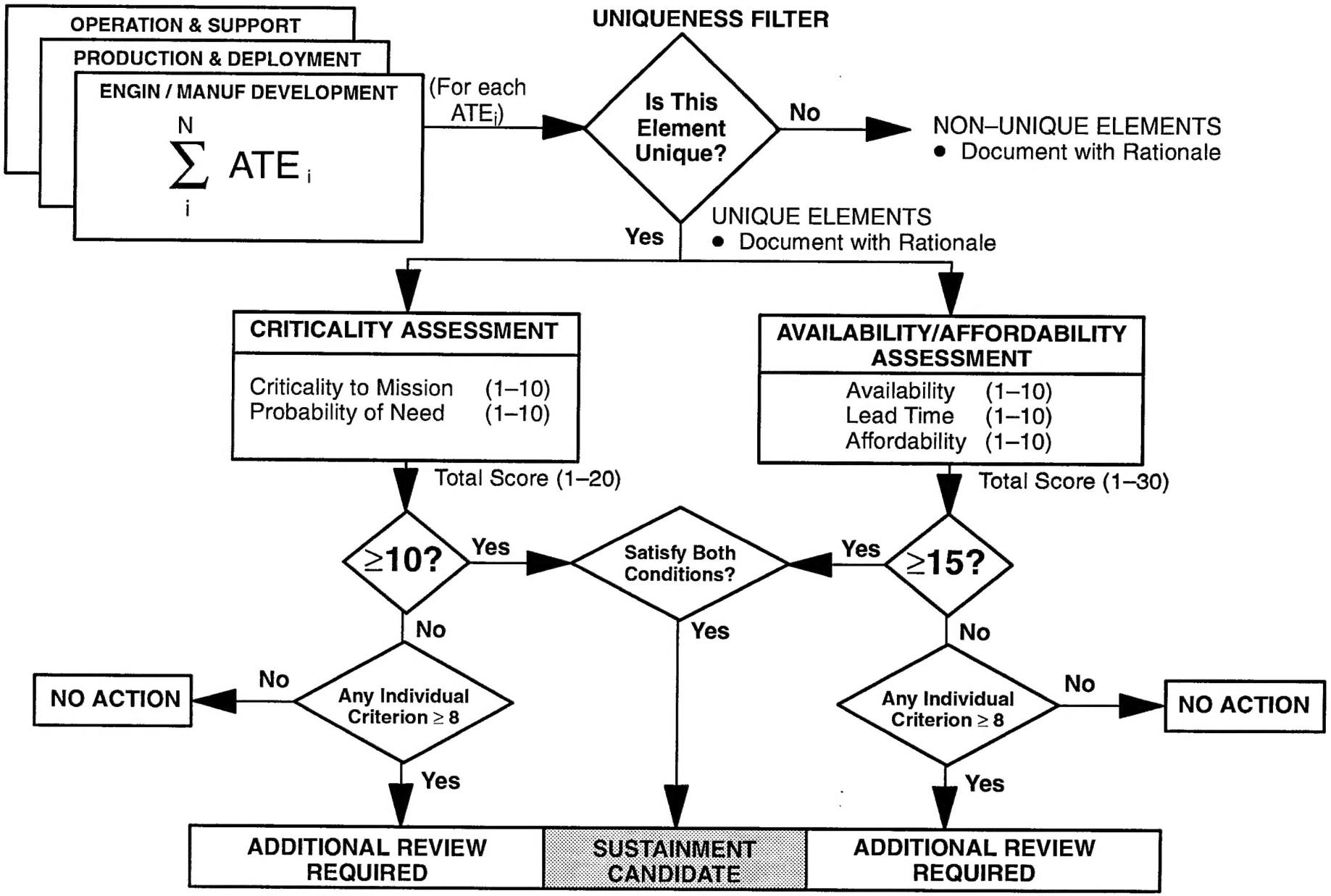

FIGURE 7: PROCESS FOR ASSESSMENT OF ACTIVITY TREE ELEMENTS (ATE)

FIGURE 8: EXAMPLE OF COMPLETED RVAP EVALUATION FORM

MARTIN MARIETTA

Prepared By: MARSKO/SPONAR/HODSON

MARTIN MARIETTA ASTRO SPACE

ACTIVITY TREE ELEMENT IDENTIFICATION

- ☐ SKILL/TOOL
- ☑ PRODUCT/PROCESS
- ☐ TESTING REQUIREMENT

Element Description: Hardened Electronic Parts

Check all that apply
SYSTEM: ☑ MK–12A ☑ MK–21 ☑ MM III R/S ☑ MK–12 ☐ MK–5

Check all that apply
PHASE: ☐ EMD ☑ PROD ☐ O & S

UNIQUENESS FILTER

- ☐ NOT UNIQUE
- ☑ UNIQUE

Rationale: UNIQUE SEMICONDUCTORS DESIGNED AND MANUFACTURED TO MEET SPECIFIC NH&S ENVIRONMENTS

****** If "Not Unique", Do not Proceed ******

CRITICALITY ASSESSMENT

Criteria	Score (1–10)	Rationale
CRITICALITY TO MISSION:	8	AVAILABILITY OF CRITICAL SEMICONDUCTORS FOR LONG TERM MAINTENANCES IS NOT ASSURED AS CURRENT VENDORS EXIT BUSINESS AND UNIQUE MANUFACTURING PROCESSES BECOME EXTINCT.
PROBABILITY OF NEED:	7	LOW TO MODERATE NEED DURING NEAR AND INTERMEDIATE TERM, BECOMES CRITICAL IN FAR TERM AS STOCK OF EXISTING PARTS IS DEPLETED AND REPLACEMENTS MUST BE OBTAINED FROM ALTERNATIVE SOURCES.
CRITICALITY TOTAL SCORE:	15	

AVAILABILITY & AFFORDABILITY ASSESSMENT

Criteria	Score (1–10)	Rationale
AVAILABILITY:	9	QUALIFIED PRODUCT LINES NO LONGER SUPPORTED, KEY PERSONNEL NOT REPLACED DUE TO DECLINING MARKET, CRITICAL PROCESSES NOT MAINTAINED, AS TECHNOLOGY SHIFTS TO COMMERCIAL PRODUCT.
LEAD TIME:	8	RESTORATION OF PRODUCT AVAILABILITY WILL REQUIRE SIGNIFICANT PROCESS RECERTIFICATION AND REQUALIFICATION.
AFFORDABILITY:	6	RECONSTITUTING PREVIOUS SOURCES OR DEVELOPING NEW ONES WILL REQUIRE FULL SUPPORT OF FACTORY SEGMENT DUE TO LIMITED MARKET FOR PARTS.
AVAILABILITY TOTAL SCORE:	23	

SCORING RESULTS

Total Criticality ≥10 AND Total Availability ≥ 15	Any Individual Criterion Score ≥ 8	
☒ SUSTAINMENT CANDIDATE	☐ ADDITIONAL REVIEW NEEDED	☐ NO ACTION

25

Score revised 6/7/95 QJR
15/26 → 15/23

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James P. Brazel
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James P. Brazel
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